

# Mobile Robots

## AUTO4508

Group Project	Autonomous Navigation	weeks 7-12
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<b>GROUPS:</b>	Form groups of 4 students
<b>EQUIPMENT:</b>	Pioneer 3-AT Outdoor Mobile Robot Platform Industrial Linux PC with touch screen display GPS: built-in IMU: Phidget Spatial 3/3/3 Camera: Stereo Camera OAK-D V2 Lidar: SICK 2D-Lidar TIM781-2174101 Software: ROS / ARIA



Each group will be assigned a Pioneer mobile robot manipulator to use for this project.

### Tasks to complete

1. Drive the robot along a path, specified through a number of given GPS waypoints. The robot has to visit each waypoint before returning to its starting position.
2. Each waypoint is marked by an orange traffic cone. Whenever a waypoint has been reached (within reasonable accuracy), the robot must take a photo of the marker object and then head towards the next waypoint. Always leave this marker to the robot's **right** side.
3. At each waypoint, an additional object (a colored bucket) will be in the vicinity, but at an unspecified distance. Identify the object, record a photo of it, and calculate its distance from the waypoint marker.
4. Upon completion of the waypoint course, print all marker photos, object photos and object distance measurements on the screen.

5. Record the robot's driving path and display it graphically on the robot's display with all detected markers, objects and any obstacles.
6. Implement a user interface with graphics and text on the robot's display that always displays the robot's internal state and its intended actions.
7. Use the Lidar sensor to avoid collisions with markers, objects and any other stationary or moving obstacles, such as walls, vehicles, people, bikes, etc.
8. For safety reasons, implement a Bluetooth link between the robot's on-board PC and a gamepad controller:
  - a. Button 'A' enable automated mode.  
In automated mode, use the back pedals as a dead-man switch.  
If released, the robot has to stop.
  - b. Button 'B' enable manual mode (disable automated mode).  
In manual mode, the steering controls can be used to manually drive the robot forward/backward and left/right.

## Getting started

You can program the robots either using the ARIA framework or the ROS software stack. Make use of the software libraries for Phidget (IMU) and OAK-D (stereo camera), sick\_scan\_xd (Lidar) as well as OpenCV (image processing).

Note that the robots are designed to **only drive outside** on grass or sand. For **indoor testing**, you need to wrap all tires with gladwrap to allow the rigid wheels to slip – otherwise the robot's motors will burn out (this already happened in the past)!

## Resources

### Pioneer:

- ARIA Library: <https://github.com/cinvesrob/Aria>

### Phidget IMU:

- User Guide: <https://www.phidgets.com/?tier=3&catid=10&pcid=8&prodid=1204>
- Code Samples <https://www.phidgets.com/?tier=3&catid=10&pcid=8&prodid=1204>

### OAK-D Camera:

- DepthAI API: <https://docs.luxonis.com/projects/sdk/en/latest/>
- Code Samples: [https://docs.luxonis.com/projects/api/en/latest/tutorials/code\\_samples/](https://docs.luxonis.com/projects/api/en/latest/tutorials/code_samples/)

### SICK Lidar:

- Info/ROS-Driver: <https://www.sick.com/fr/en/tim781-2174101/p/p594148>
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## VIDEO

Create a video of about 1 min. in length that shows your robot's capabilities. If anything goes wrong during demonstration day, at least you have the fallback of the video. Submission is in week 11, one week before the project demonstration.

## DEMONSTRATION

On the scheduled presentation day at the end of the semester, all groups will give a practical demonstration of their projects and answer the project supervisors' questions re. their implementation.

## SUBMISSION

Submit a hardcopy and softcopy with official coversheet incl. declarations of all team members:

1. Project design report (*pdf*), which includes
  - Report on which team member did what
  - Software design description
  - Diagrams, photos, screenshots, plots, etc.
  - Include page numbers
  - Max 10 pages plus 1 Title page

**Do NOT include:**

  - Program code
  - Table of contents, etc.
  - Half-empty pages
2. User Manual (*pdf*)
  - Max 5 pages, **no** Title page
  - As if it was sold to a customer
3. Source code (*email to project supervisor only, no hardcopy*), clearly marking any imported code with referencing the source.

## MARKING

60% Functional Performance, Design, Complexity, Innovation  
20% Project Design Report  
10% Video  
10% User Manual